EFFECT OF HEAT STRESS TOWARDS JOB PERFORMANCE AMONG WORKERS IN PALM OIL MILL

MUHAMMAD AIMAN ALIF BIN MOHD RAPEI

BACHELOR OF OCCUPATIONAL SAFETY AND HEALTH (HONS)

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor of Occupational Safety and Health (Hons.).

_____

(Supervisor's Signature)

Full Name : DR NORAZURA BINTI ISMAIL

Position : LECTURER

Date : 18 JANUARY 2019

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

_____

(Student's Signature)

Full Name : MUHAMMAD AIMAN ALIF BIN MOHD RAPEI

ID Number : PA15042

Date : 18 JANUARY 2019

EFFECT OF HEAT STRESS TOWARDS JOB PERFORMANCE AMONG WORKERS IN PALM OIL MILL

MUHAMMAD AIMAN ALIF BIN MOHD RAPEI

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Occupational Safety and Health with Honors

Faculty of Engineering Technology

UNIVERSITI MALAYSIA PAHANG

JANUARY 2019

ACKNOWLEDGEMENTS

First and foremost, all the gratitude and gratefulness for Allah Almighty, for His willingness, allowed me to accomplish the final year project as the requirement for my graduation of Bachelor of Occupational Safety and Health with Honors in Universiti Malaysia Pahang (UMP). Thank you very much for giving me strength to complete my research after all the obstacle I have been through.

In addition, I would like to express the deepest expression to my supervisor, Dr, Norazura binti Ismail for her invaluable guidance, continue encouragement and constant support throughout the course of thesis. I appreciate her consistent support from the beginning until the end stags of this project. I sincerely thank her for the time she spent on me and correcting all my mistakes.

Last but not least, my sincere thanks to my parents and all my friends who always helped me in many ways, supporting and encourage me. Thank you very much for everyone who involved directly and indirectly in this project from the beginning of this project until its completion for their cooperation, advice and support throughout the process.

ABSTRAK

Komponen haba persekitaran atmosfera merupakan satu isu penting yang berkaitan dengan kesihatan manusia. Haba persekitaran termasuk kedua-dua syarat-syarat Pertukaran haba (tekanan) dan tindak balas fisiologi (tekanan). Tujuan kajian ini adalah untuk menentukan kesan haba tekanan di kalangan pekerja di kilang minyak sawit. Suhu persekitaran dan tindak balas fisiologi pekerja seperti kadar degupan jantung dan teras suhu badan diukur antara 28 pekerja dalam kajian ini. Suhu dunia mentol basah (WBGT) telah digunakan untuk mengukur pendedahan haba alam sekitar, WBGTin dan kelembapan. Kadar degupan jantung telah diukur dengan menggunakan alat BUA50 MEDISANA yang tekanan darah automatik. Manakala suhu teras badan ini diukur dengan menggunakan alat FLUKE termometer inframerah 572-2. Borang soal selidik telah digunakan untuk mendapatkan data demografi, gejala-gejala kesihatan dan haba berkaitan penyakit yang dialami oleh pekerja. Keputusan menunjukkan purata WBGTin bagi setiap stesen kerja; Bilik enjin (29.34 °C), pensterilan (29.03 °C), Bilik minyak (30.15 °C) dan Stesen dandang (28.88 °C) adalah sedikit di atas nilai had minimum (TLV) daripada ACGIH (27.5 °C). Di samping itu, purata kadar jantung diukur sebelum dan selepas 4 jam kerja adalah di bawah daripada kadar degupan jantung biasa dicadangkan (110 bpm). Sementara itu, purata suhu badan diukur sebelum dan selepas 4 jam kerja adalah di bawah had yang disarankan oleh ACGIH Time-Weighted purata (< 38°C). Tidak ada perbezaan kepentingan perubahan fisiologi sebelum kerja dan selepas empat jam kerja. Oleh yang demikian, tiada korelasi yang signifikan antara tekanan haba persekitaran dan tekanan haba peribadi. Tiada faktor-faktor yang ketara berkaitan dengan pembebasan haba peribadi. Walaupun pendedahan persekitaran haba telah melebihi nilai had ACGIH, tahap stres haba peribadi tidak sampai ke tahap tidak boleh diterima standard fisiologi. Ia mungkin proses senaman yang merupakan sebuah badan individu menyesuaikan diri secara beransur-ansur perubahan dalam persekitarannya, membolehkannya mengekalkan prestasi merentasi pelbagai keadaan persekitaran. Mengekalkan amalan-amalan kerja yang disyorkan untuk mengekalkan prestasi mereka dan meminimumkan risiko kesihatan pekerja.

ABSTRACT

Thermal component of the atmospheric environment is an important issue which is related to human's health. Thermal environment includes both heat exchange conditions (stress) and the physiological response (strain). The aim of this study is to determine the effect of heat stress among the workers in palm oil mill. Environmental temperature and physiological reactions of workers such as heart rate and core body temperature were measured among 28 workers in this study. Wet Bulb Globe Temperature (WBGT) were used to measure the environmental heat exposure, WBGTin and relative humidity. Heart rate were measured using an MEDISANA BUA50 Automatic Blood Pressure Monitor while body core temperature was measured using an FLUKE 572-2 Infrared Thermometer. A questionnaire was used to obtain the demographic data, health symptoms and heat related illness that experienced by the workers. Result shows the average of WBGTin for each workstation; engine room (29.34 °C), sterilization (29.03 °C), oil room (30.15 °C) and boiler station (28.88 °C) were slightly above the Threshold Limit Value (TLV) of ACGIH (27.5 °C). In addition, the average heart rate measured before and after 4 hours of work were below than the suggested normal heart rate (110 bpm). Meanwhile, the average of body temperature measured before and after 4 hours of work were below the limit that recommended by ACGIH Time-Weighted Average (<38 °C). There was no significance difference in physiological changes before work and after four hour of work. Therefore, there are no significant correlation between environmental heat stress and personal heat stress. None of the factors significantly associated with personal heat stress. Even though the environmental heat exposure were above the ACGIH's threshold limit value, the personal heat stress level did not reach unacceptable level of physiological standard. It maybe the process of acclimatization which is an individual body adjust to a gradual change in its environment, allowing it to maintain performance across range of environmental conditions. Maintain works practices are recommended to maintain their performance and minimize health risks of workers.

TABLE OF CONTENT

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF SYMBOLS

°C	Temperature
%	Percentage
bpm	Beat per minute

LIST OF ABBREVIATIONS

WBGT	Wet Bulb Globe Temperature
NWB	Nature Wet-Bulb
DB	Dry Bulb
GT	Globe Tempearture
Rh	Relative Humidity
HI	Heat Index
ACGIH	American Conference of Governmental Industrial Hygeniest
AL	Action Limit
TLV	Threshold Limit Value

CHAPTER 1

INTRODUCTION

1.1 Introduction

Heat stress includes a series of conditions where the body is under stress from overheating. Heat is one of the physical hazards that can cause health problems in the workplace (Kjellstrom,2009). The most important and common occupational health problems in workplaces is inappropriate thermal conditions that can impact the health and productivities of workers (Venugopal,2015). Daily heat exposure during the hot temperature is a problem particularly for people working in jobs that cannot be, or are not cooled by air conditioning or other technical methods. Workers who are exposed to extreme heat or work in hot environments may be at risk of heat stress. Exposure to extreme heat can result in occupational illnesses and injuries. Heat can also increase the risk of injuries in workers as it may result in sweaty palms, fogged-up safety glasses, and dizziness. Workers at risk of heat stress include outdoor workers and workers in hot environments such as firefighters, bakery workers, farmers, construction workers, miners, boiler room workers, factory workers, steel workers and others.

Since the internal body temperature should be kept around 37 °C, heat exchange between human body and surrounding environment seems to be essential (Parsons,2003). Body must reach thermal equilibrium by dissipating excess heat transferred to the body and produced in the body. Failure to remove excessive heat will cause an increase in the deep body temperature (Gonzalez,2010). Consequently, heat induced physiological strain may lead to health impairments such as heat stroke, heat exhaustion, heat cramps, heat collapse, heat rashes, and heat fatigue.

In other hand, different factors including type of task, duration of the exposure, intensity of the stressor, and operators' skill level are key variables influencing the extent that thermal conditions influence the performance. However, it had been shown that simple tasks are less affected by heat stress, comparing to the complex tasks such as tracking, monitoring, and multiple tasks.

1.2 Background of Study

Workers labouring in palm oil mill in tropical settings with high ambient temperatures are subjected to thermally stressful environments that can create risks of heat- related illnesses and cause to heat stress.

In palm oil mill, the working hours for the workers is 8 hours per day with some workers doing overtime of 1–2 hours on random days during peak production. A hot environment combined with physically demanding tasks in long period of time can subject workers to a higher risk of heat stress. Hence, most of worker could not avoid from suffering heat stress while doing their work in palm oil mill. Places such as loading ramp, sterilization, thresher, kernel, press, production room, engine room, boiler room and workshop in the palm oil mill are the locations that workers may suffer high level of heat stress (Karmegam, 2012). The process in the palm oil mill involved radiation heat which is the distance between workers with the source of heat are nearer. Therefore, the heat exposure among workers are high. High temperature has been found to be associated with lower productivity of work, raised in the frequency of accident and performance of workers are reduce (Kjellstrom&Dirks,2001).

This research is conducted to investigate the effect of heat stress among workers who work at hot environment in palm oil mill. Job performance of workers and their awareness that caused by hot environment was assessed by using a set of questionnaire. Meanwhile, Wet Bulb Globe Temperature(WBGT), blood pressure monitor, and thermometer was used to measure the heat in the hot thermal environment.

1.3 Problem Statement

In developing countries, palm oil mill is one of important economic industries. Workers in palm oil mill are more likely exposed to excessive heat stress during their working time. People working in various industries are exposed to excessive heat burden in addition to environmental temperature (Parsons,2002). In addition, worker in palm oil mill are more exposed of radiant heat source while their working. Outdoor temperatures are quite similar with indoors in agriculture sectors with process generated heat. Workers that exposed to heat stress was higher value than the threshold limit values recommended by the American Conference of Governmental Industrial Hygienists (ACGIH,2015). In palm oil mill, the heat stress of workers was higher than the standard level (Ansari,2014). Other than that, excessive heat stress of the workers in palm oil mill also involve indoor and outdoor activities. Lucas, (2014) stated that outdoor workers are exposed to sunlight and wind, indoor workers are exposure to radiant heat sources or without adequate ventilation, or those workers were not acclimatized can lead to heat stress and stroke in the workplace. (Kjellstrom, 2009; Hanna, 2011 and Xiang, 2014) found that, in high temperature, risk of heat- related illnesses and injuries were increasing in many types of indoor and outdoor worker's activities. Heat-generating sources at work, high external air temperatures, or a combination of both can causes workplace exposure to heat (Heat Stress in The Workplace,2008).

Currently, there is a lack of research about the effects of heat stress on the performance and productivity of humans. Moreover, the existing data on the real exposure of workers to high-temperature environments and reduced productivity and efficiency are rather ambiguous (Lin, 2009 and Behesti, 2016). If the necessary control measures are not taken, high workplace temperature may have considerable effects on productivity, occupational efficiency, and their related costs.

REFERENCES

Anon. (1979). Adopted By ACGIH For 1979 Threshold Limit Values For Physical Agents. *National Safety News*.

Atan, L., Andreoni, C., Ortiz, V., Silva, E. K., Pitta, R., Atan, F., & Srougi, M. (2005). High kidney stone risk in men working in steel industry at hot temperatures. *Urology*, *65*(5), 858–861. http://doi.org/10.1016/j.urology.2004.11.048

Baura, G. D. (2012). Blood Pressure Monitors. In *Medical Device Technologies*. http://doi.org/10.1016/B978-0-12-374976-5.00007-4

Bilchick, K. C., & Berger, R. D. (2006). Heart rate variability. *Journal of Cardiovascular Electrophysiology*. http://doi.org/10.1111/j.1540-8167.2006.00501.x

Chobanian, A. (2003). Prevention , Detection , Evaluation , and Treatment of. *Blood Pressure*. http://doi.org/10.1161/01.HYP.0000107251.49515.c2

Cortez, O. D. (2009). Heat stress assessment among workers in a Nicaraguan sugarcane farm. *Global Health Action*, *2*(1).

Dehghan, H., Mortazavi, S. B., Jafari, M. J., & Maracy, M. R. (2012). Evaluation of wet bulb globe temperature index for estimation of heat strain in hot/humid conditions in the persian gulf. *Journal of Research in Medical Sciences*.

Dutta, P., Rajiva, A., Andhare, D., Azhar, G. S., Tiwari, A., & Sheffield, P. (2015). Perceived heat stress and health effects on construction workers. *Indian Journal of Occupational and Environmental Medicine*, *19*(3), 151–158. http://doi.org/10.4103/0019-5278.174002

Ferrell, J. K., & Stahel, E. P. (1966). Heat transfer. *Industrial and Engineering Chemistry*. http://doi.org/10.1021/ie50684a008

Garzón-Villalba, X. P., Wu, Y., Ashley, C. D., & Bernard, T. E. (2017). Ability to discriminate between sustainable and unsustainable heat stress exposures - Part 2: Physiological indicators. *Annals of Work Exposures and Health*. http://doi.org/10.1093/annweh/wxx035

Garzón-Villalba, X. P., Wu, Y., Ashley, C. D., & Bernard, T. E. (2018). Heat stress risk profiles for three non-woven coveralls. *Journal of Occupational and Environmental Hygiene*. http://doi.org/10.1080/15459624.2017.1388514

Ghanbary Sartang, A., Palyzban, F., Abedi, M., & Abedi, H. (2017). Heat stress assessment according to the wet-bulb globe temperature (WBGT) index among workers of a steel mill in 2014. *Journal of Occupational Health and Epidemiology*. http://doi.org/10.29252/johe.6.3.165

Habibi, P., Dehghan, H., Haghi, A., & Shakerian, M. (2015). The Relationship Between Wet Bulb Globe Temperature and Physiological Strain Index in Muslim Women in Hot-Dry Condition in the Climatic Chamber. *Health Scope*.

Hamilton, P. A., Marcos, L. S., & Secic, M. (2013). Performance of infrared ear and forehead thermometers: A comparative study in 205 febrile and afebrile children. *Journal of Clinical Nursing*. http://doi.org/10.1111/jocn.12060

Hasanuzzaman, M., Nahar, K., Alam, M. M., Roychowdhury, R., & Fujita, M. (2013). Physiological, biochemical, and molecular mechanisms of heat stress tolerance in plants. *International Journal of Molecular Sciences*. http://doi.org/10.3390/ijms14059643

Horie, S. (2013). Prevention of heat stress disorders in the workplace. *Japan Medical Association Journal*.

Hunt, A. P., Parker, A. W., & Stewart, I. B. (2014). Heat strain and hydration status of surface mine blast crew workers. *Journal of Occupational and Environmental Medicine*. http://doi.org/10.1097/JOM.0000000000000114

Huss, R. G., Skelton, S. B., Alvis, K. L., & Shane, L. A. (2013). Heat Stress Management Program Improving Worker Health and Operational Effectiveness: A Case Study. *Workplace Health & Safety*, *61*(3), 128–133.

Jay, O., & Kenny, G. P. (2010). Heat exposure in the Canadian workplace. *American Journal of Industrial Medicine*. http://doi.org/10.1002/aiim.20827

Kawanami, S., Horie, S., Inoue, J., & Yamashita, M. (2012). Urine temperature as an index for the core temperature of industrial workers in hot or cold environments. *International Journal of Biometeorology*. http://doi.org/10.1007/s00484-011-0516-4

Kjellstrom, T., Holmer, I., & Lemke, B. (2009). Workplace heat stress, health and productivity-an increasing challenge for low and middle-income countries during climate change. *Global Health Action*. http://doi.org/10.3402/gha.v2i0.2047

Krishnamurthy, M., Ramalingam, P., Perumal, K., Kamalakannan, L. P., Chinnadurai, J., Shanmugam, R., … Venugopal, V. (2016). Occupational heat stress impacts on health and productivity in a steel industry in Southern India. *Safety and Health at Work*, (November), 6–11. http://doi.org/10.1016/j.shaw.2016.08.005

Kuht, J., & Farmery, A. D. (2018). Body temperature and its regulation. *Anaesthesia and Intensive Care Medicine*. http://doi.org/10.1016/j.mpaic.2018.06.003

Lamarche, D. T., Meade, R. D., D'Souza, A. W., Flouris, A. D., Hardcastle, S. G., Sigal, R. J., … Kenny, G. P. (2017). The recommended Threshold Limit Values for heat exposure fail to maintain body core temperature within safe limits in older working adults. *Journal of Occupational and Environmental Hygiene*. http://doi.org/10.1080/15459624.2017.1321844

Lin, R.-T., & Chan, C.-C. (2009). Effects of heat on workers' health and productivity in Taiwan. *Global Health Action*, *2*(1), 2024. http://doi.org/10.3402/gha.v2i0.2024

LUNDGREN, K., KUKLANE, K., GAO, C., & HOLM^|^Eacute;R, I. (2013). Effects of Heat Stress on Working Populations when Facing Climate Change. *Industrial Health*. http://doi.org/10.2486/indhealth.2012-0089

Mahan, J. R., & Yeater, K. M. (2008). Agricultural applications of a low-cost infrared thermometer. *Computers and Electronics in Agriculture*. http://doi.org/10.1016/j.compag.2008.05.017

Meade, R. D., D'Souza, A. W., Krishen, L., & Kenny, G. P. (2017). The physiological strain incurred during electrical utilities work over consecutive work shifts in hot environments: A case report. *Journal of Occupational and Environmental Hygiene*. http://doi.org/10.1080/15459624.2017.1365151

Mohammad Yusof, N. A. D., Tamrin, D. S. B. M., & Karmegan, K. (2014). Heat Related Illness in Palm Oil Mill Workers under Heat Stress. *Advances in Environmental Biology*.

Moran, D. S., & Mendal, L. (2002). Core temperature measurement: Methods and current insights. *Sports Medicine*. http://doi.org/10.2165/00007256-200232140-00001

Nur Athirah Diyana Mohammad Yusof, Karmegam Karuppiah, S. B. M. T. (2014). Heat Related Illness in Palm Oil Mill Workers under Heat Stress. *Advances in Environmental Biology*, *8*(15), 171–176.

Nur Athirah Diyana Mohammad Yusof, Karmegam Karuppiah, S. B. M. T. (2014). Heat Related Illness in Palm Oil Mill Workers under Heat Stress. *Advances in Environmental Biology*, *8*(15), 171–176.

Omboni, S., Riva, I., Giglio, A., Caldara, G., Groppelli, A., & Parati, G. (2007). Validation of the Omron M5-I, R5-I and HEM-907 automated blood pressure monitors in elderly individuals according to the international protocol of the European society of hypertension. *Blood Pressure Monitoring*. http://doi.org/10.1097/MBP.0b013e32813fa386

Paull, J. M., & Rosenthal, F. S. (1987). Heat Strain and Heat Stress for Workers Wearing Protective Suits at a Hazardous Waste Site. *American Industrial Hygiene Association Journal*. http://doi.org/10.1080/15298668791385048

Quinn, A., Tamerius, J. D., Perzanowski, M., Jacobson, J. S., Goldstein, I., Acosta, L., & Shaman, J. (2014). Predicting indoor heat exposure risk during extreme heat events. *Science of the Total Environment*, *490*, 686–693. http://doi.org/10.1016/j.scitotenv.2014.05.039

Ramphal-Naley, L. (2012). Screening for Heat Stress in Workers and Athletes. *Baylor University Medical Center Proceedings*. http://doi.org/10.1080/08998280.2012.11928832

Stoskopf, M. K., Spelman, L. H., Sumner, P. W., Redmond, D. P., Jochem, W. J., & Levine, J. F. (1997). The impact of water temperature on core body temperature of North American river otters (Lutra canadensis) during simulated oil spill recovery washing protocols. *Journal of Zoo and Wildlife Medicine*.

Tanaka, H., Monahan, K. D., & Seals, D. R. (2001). Age-predicted maximal heart rate revisited. *Journal of the American College of Cardiology*. http://doi.org/10.1016/S0735-1097(00)01054-8

Varley, F. (2004). A study of heat stress exposures and interventions for mine rescue workers. *Society for Mining Metallurgy and Exploration: Transactions*, *316*(04), 135–142. Retrieved from http://www.minerescue.org/conferences/2005_Sydney/7.3 USA-Turcott- Varley-Paper.pdf

Vrijkotte, T. G. M., Van Doornen, L. J. P., & De Geus, E. J. C. (2000). Effects of work stress on ambulatory blood pressure, heart rate, and heart rate variability. *Hypertension*. http://doi.org/10.1161/01.HYP.35.4.880

Xiang, J., Bi, P., Pisaniello, D., & Hansen, A. (2014). Health impacts of workplace heat exposure: An epidemiological review. *Industrial Health*, *52*(2), 91–101. http://doi.org/10.2486/indhealth.2012-0145

Zander, K. K., Moss, S. A., & Garnett, S. T. (2017). Drivers of self-reported heat stress in the Australian labour force. *Environmental Research*, *152*, 272–279. http://doi.org/10.1016/j.envres.2016.10.029